

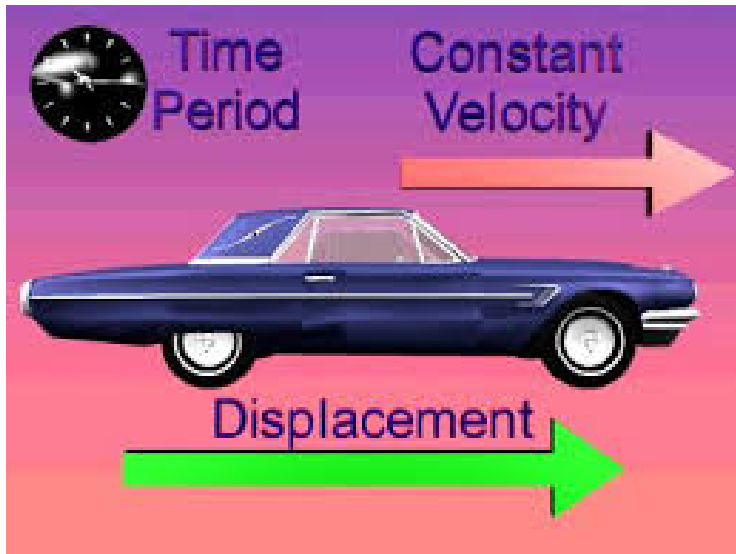
# Kinematics & Basics

Muntaha Rafiq

# Kinematics:

The study of object movements irrespective of their speed or style of movement (Force & Mass)

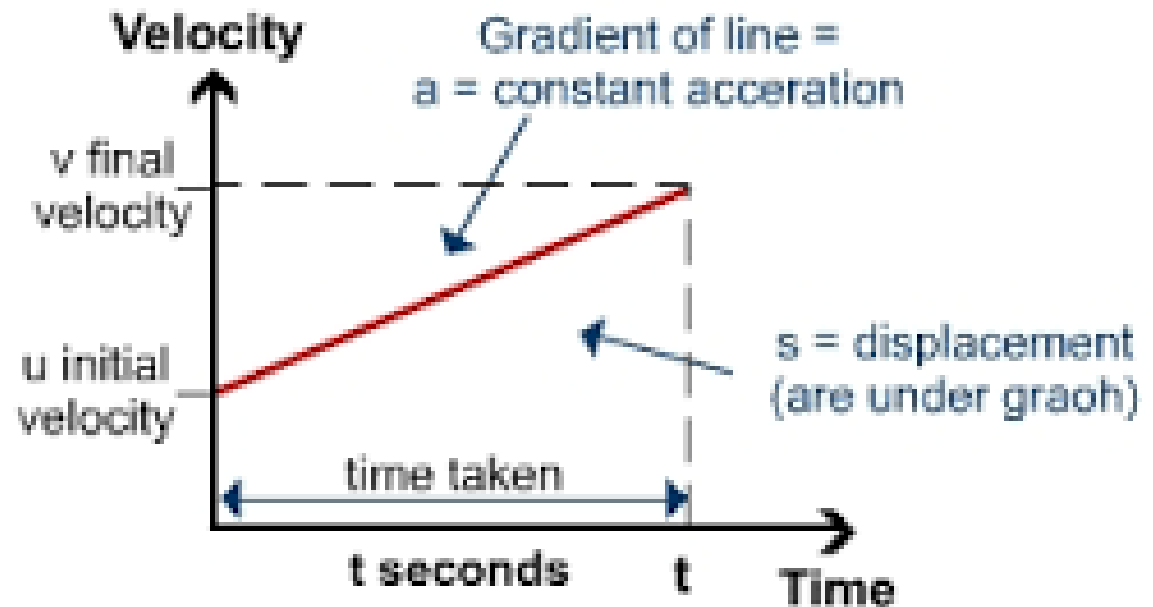
Examples: Car/Train moving, moving water in a river.



# Variables of Kinematics

There are three basic kinematic variables:

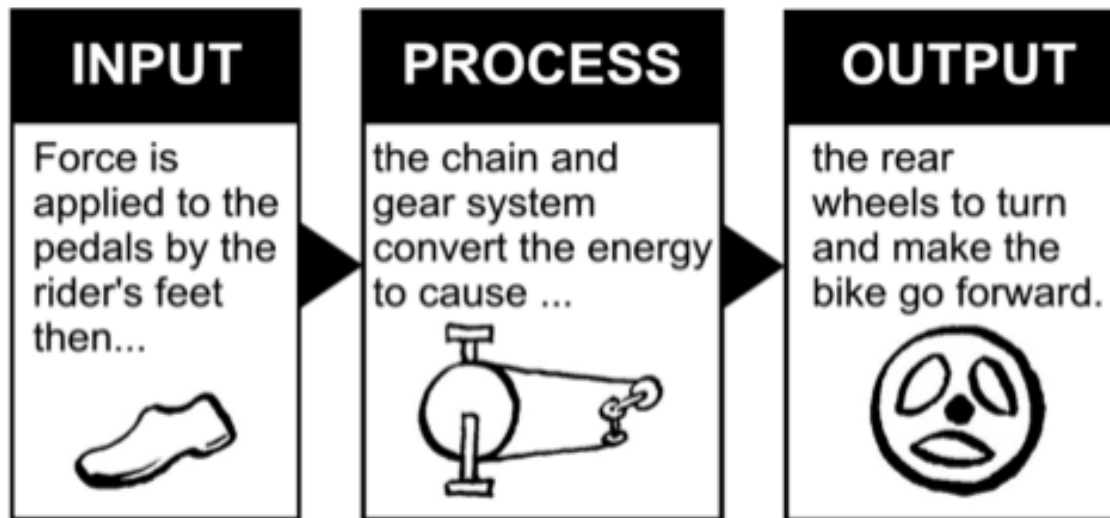
- Position
- velocity
- Acceleration



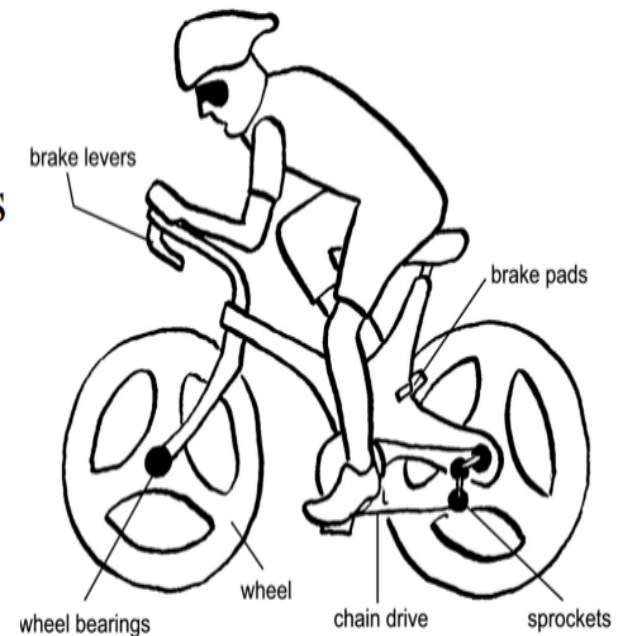
## Mechanism:

The devices which transform motion to a desirable pattern and typically develop very low forces and transmit little power.

Example: Bicycle, Go Carts etc



*Systems diagram for a bike as a mechanism*



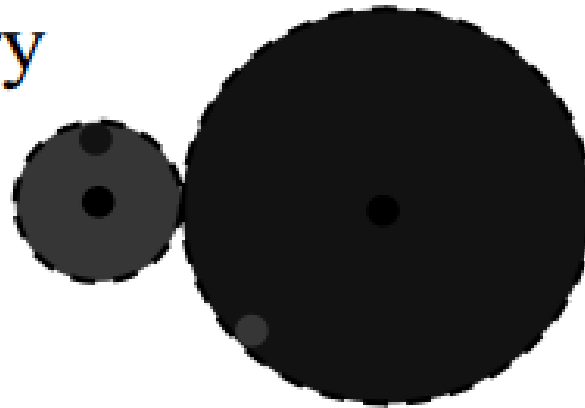
## **Mechanism:**

Generally used to:

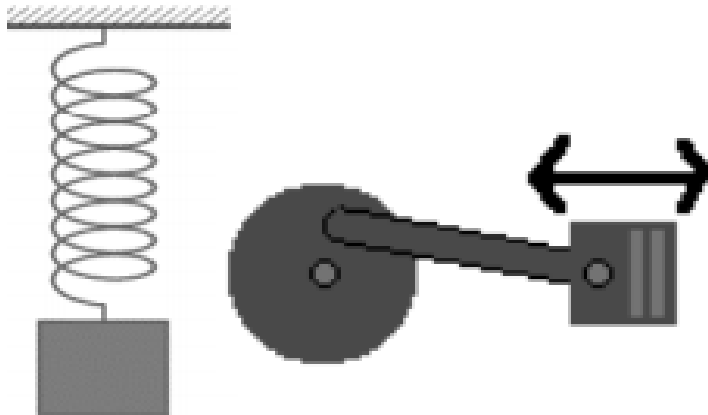
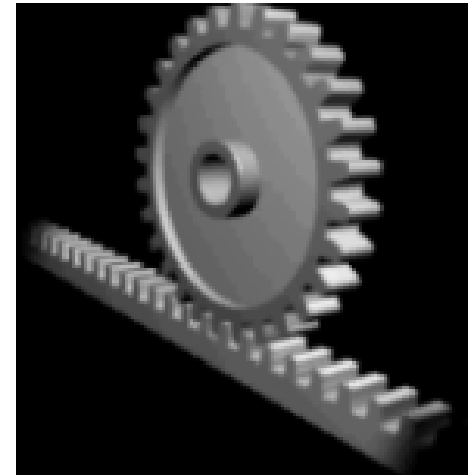
- Change the direction of movement
- Change the type of movement
- Change the speed of movement
- Change the amount of torque or force available to do work

## Different Mechanisms of Movement:

Rotary



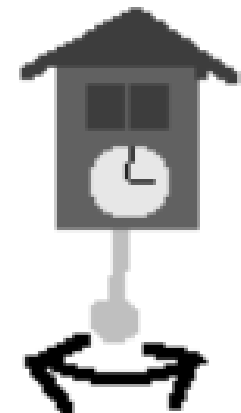
Linear



Oscillating



Reciprocating

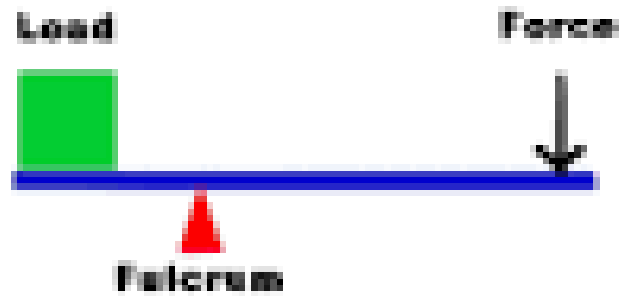


## Machine:

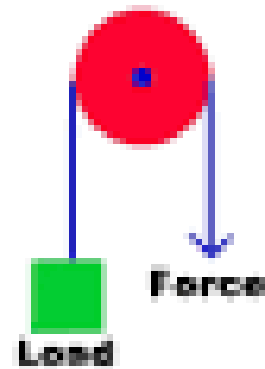
- Any mechanical or electrical device that transmits or modifies energy to perform any task.
- A machine is a device that helps people to carry out tasks more easily.



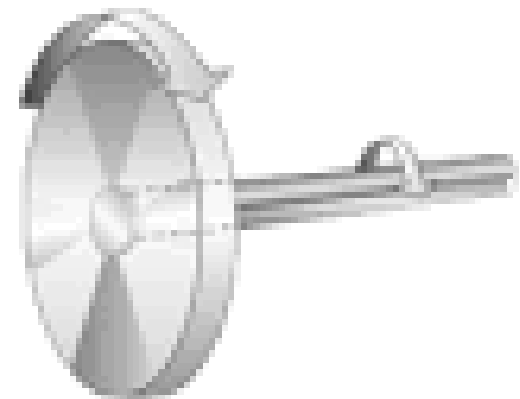
# *Simple Machines*



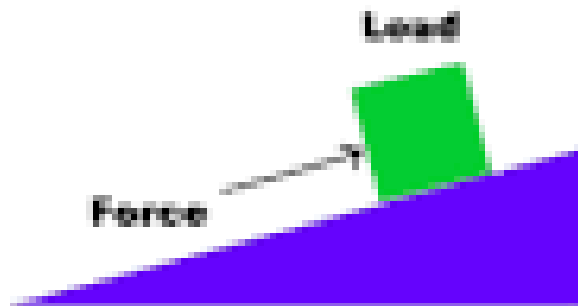
Lever



Pulley



Wheel & Axle



Inclined Plane



Wedge

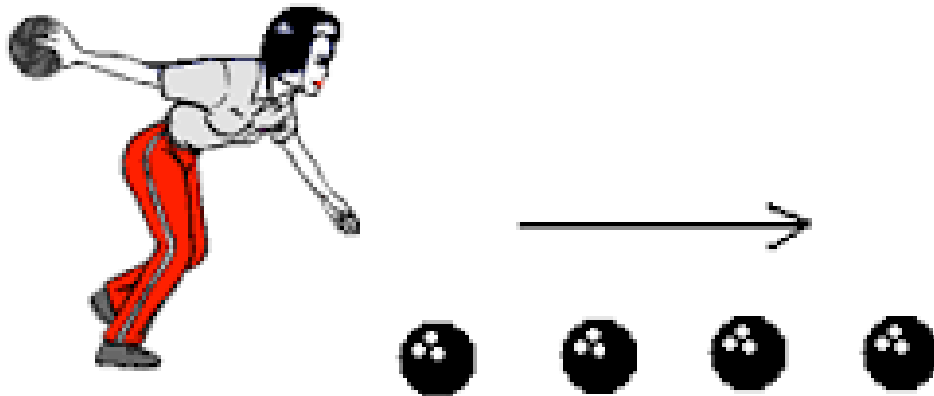


Screw



## Motion:

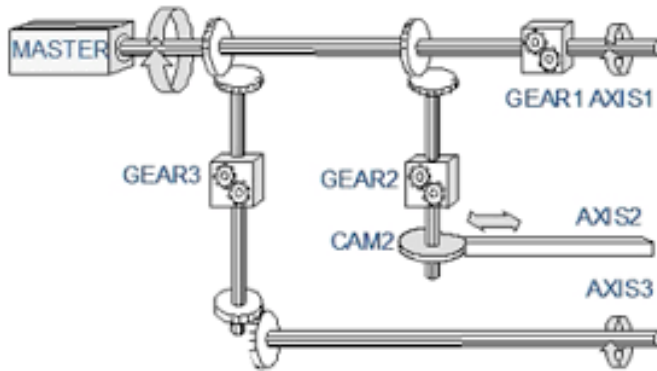
Motion is a change in position of an object with respect to time and its reference point. Motion is observed by attaching a frame of reference to a body and measuring its change in position relative to another reference frame.



# Types of Motion:

There are three types of motion:

1. Rotational..... Angular direction motion
2. Translational..... Linear direction motion
3. Complex..... Combination of rotational & translational



**Links:**

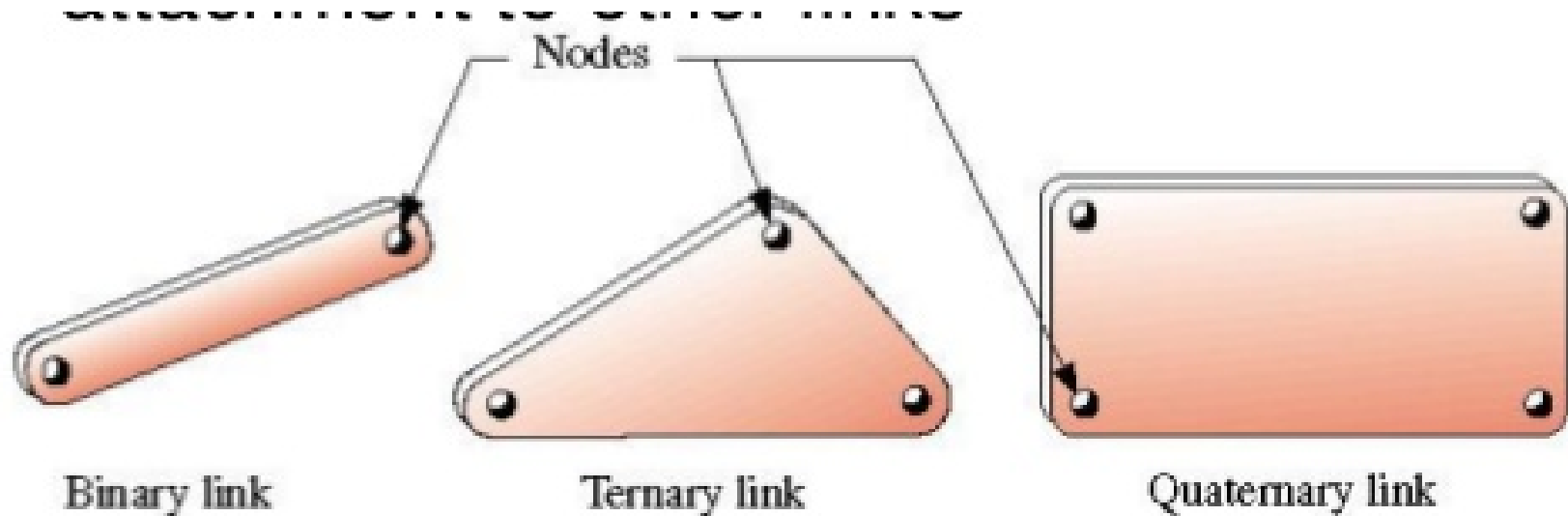
The rigid body which possesses at least two nodes.

**Nodes:** Points of Attachments with other body.

## Types of Links:

There are three types of links

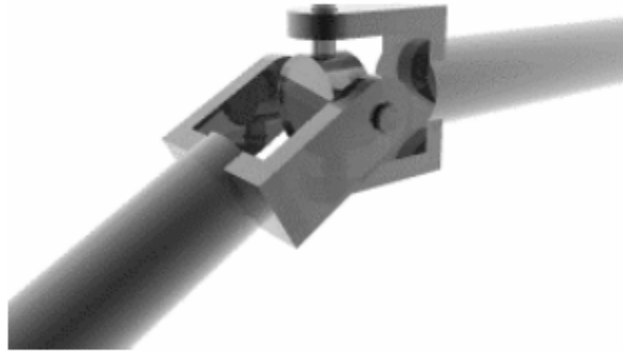
1. Binary..... Two further links
2. Ternary..... Three further links
3. Quaternary..... Four further links



## Joints:

A connection between two links is called a joint. It helps to transmit a motion.

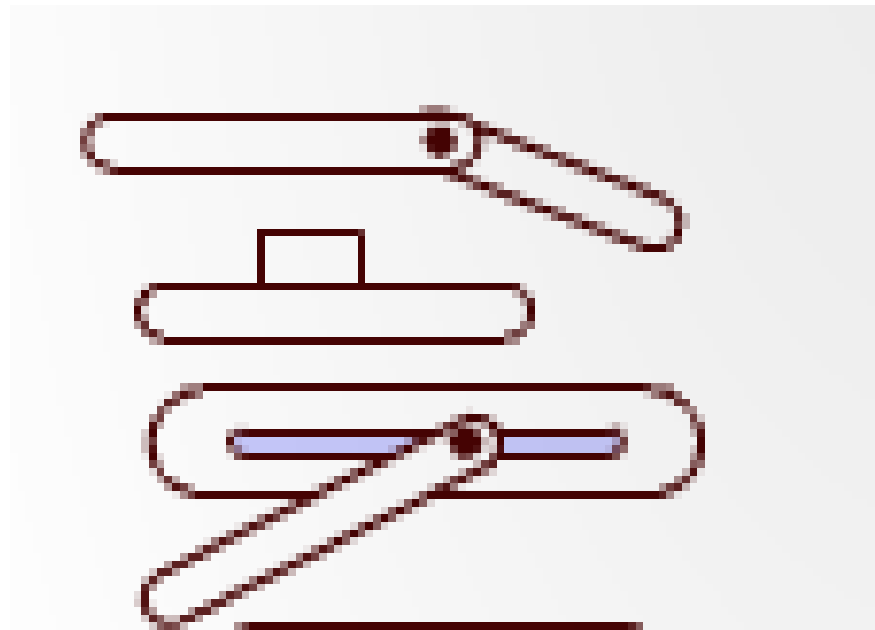
Joints can be classified according to type of contact, number of DOF, type of physical closure and number of links joined.



# Joint Classification

## Type of contact:

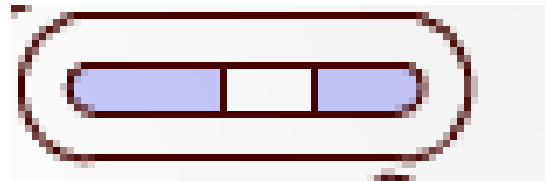
- Line
- Point
- Surface



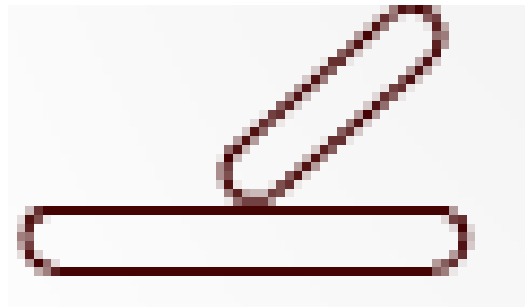
# Joint Classification

## Type of physical closure:

- **Form Closed:** Closed by geometry



- **Force closed:** Needs an external force to keep it close



# Joint Classification

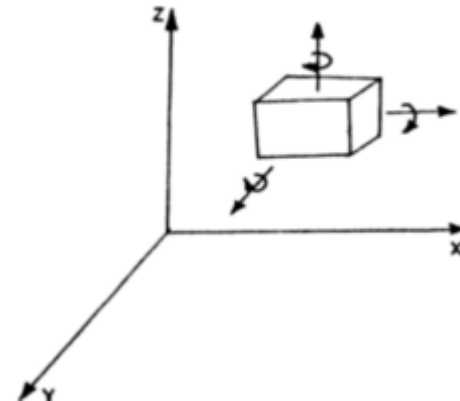
## Number of DOF:

There are basic two categories of joints w.r.t DOF

1. One freedom joint
2. Two freedom joint

## Degree of Freedom:

The number of independent coordinates required to define object's position.

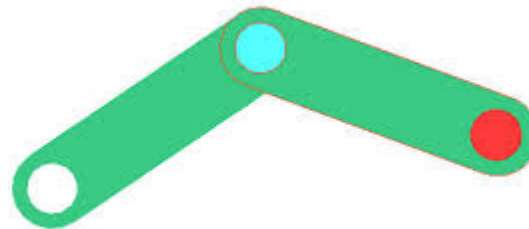




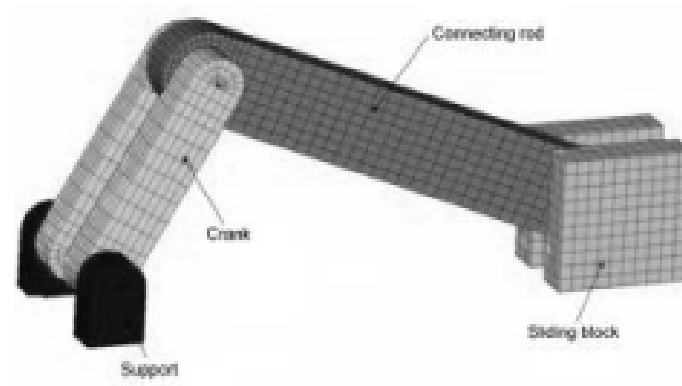
# Types of Joints:

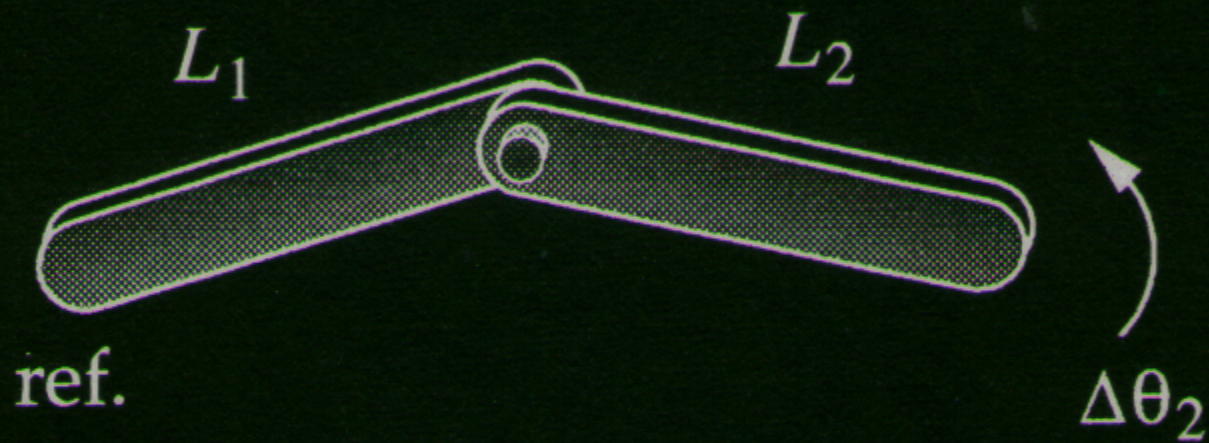
## 1. One freedom joint: (Full joint)

### a) Rotating Pin Joint:



### b) Translating Slider Joint:



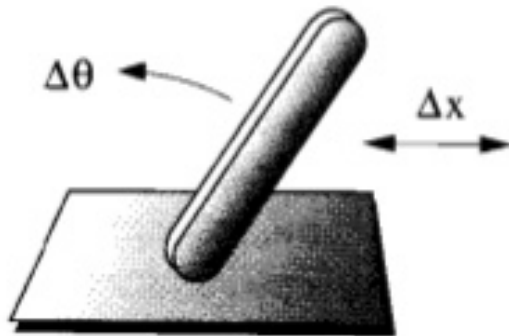


**First Order Pin Joint - Two Links  
(Degree of Freedom One)**

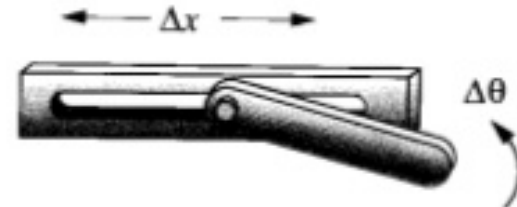
## Two freedom joint (Half Joint):

a) Joint against Plane:

b) Pin in Slot:



Link against plane



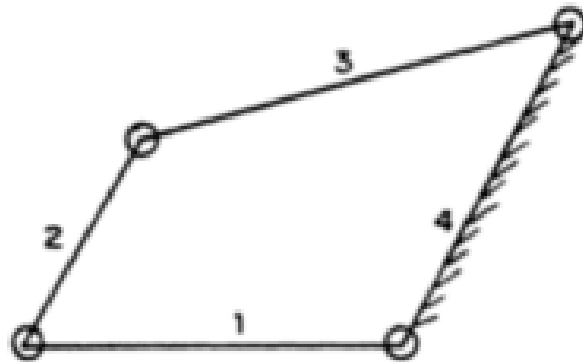
Pin in slot

Roll-slide (half or RP) joints - 2 *DOF*

# Joint Classification

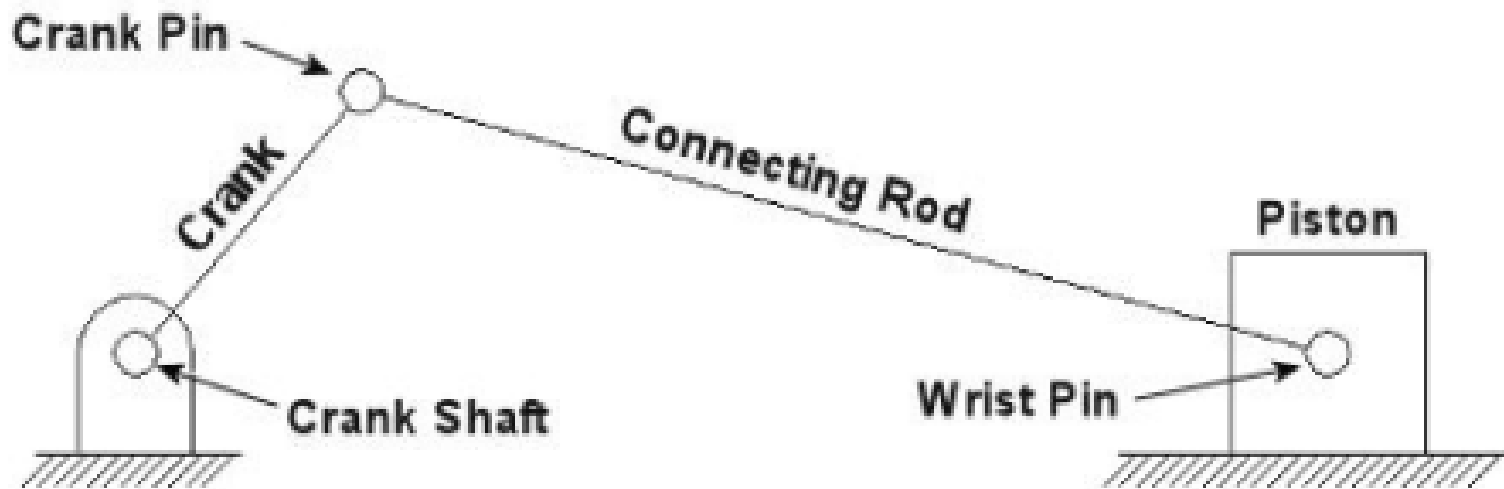
**Joint order:**

Number of links joined



## Kinematics' Chain:

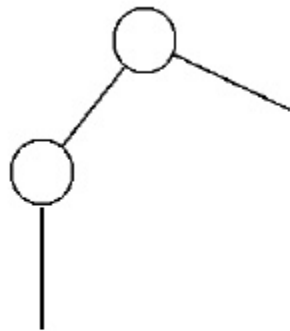
Links and joints interconnected in a way to provide a controlled output motion in response to a supplied input motion (force).



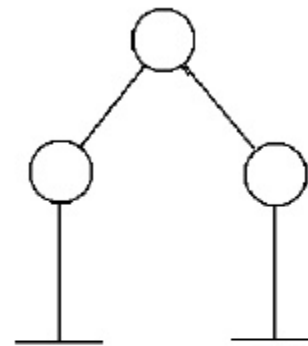
# Types of Kinematics' Chains:

- Open Kinematics' Chains
- Closed Kinematics' Chains

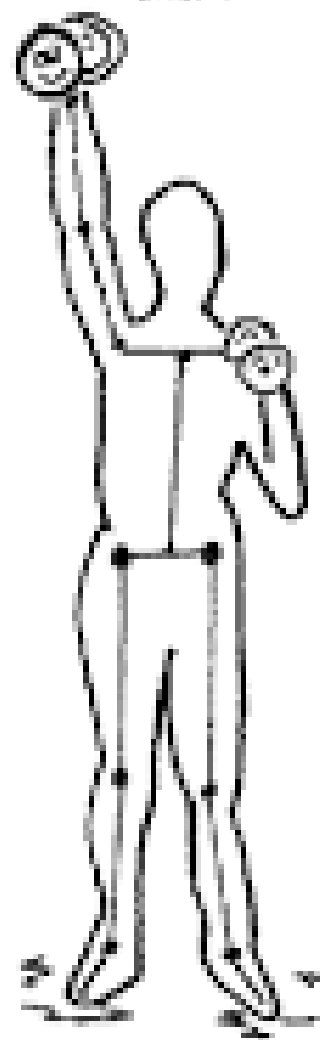
Open Loop



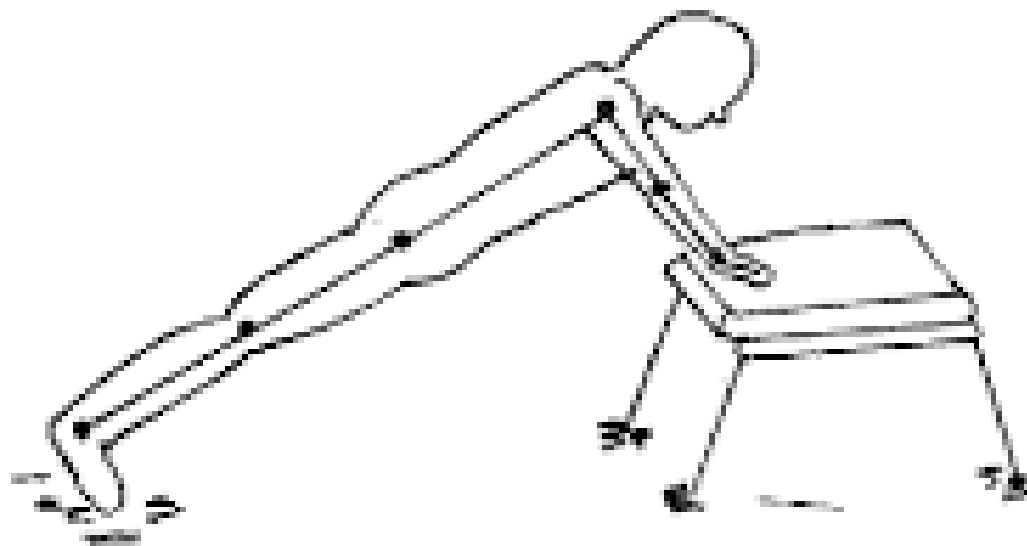
Closed Loop



Open chain

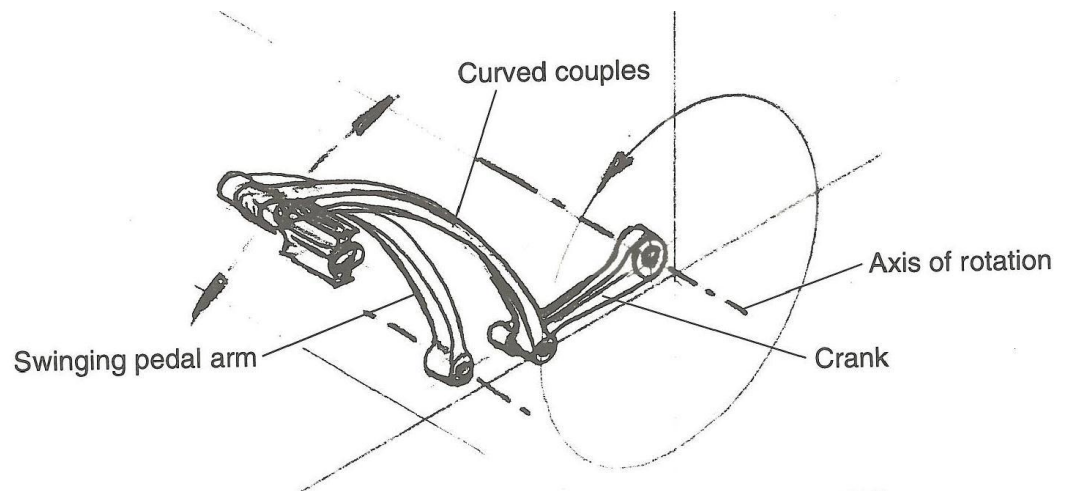
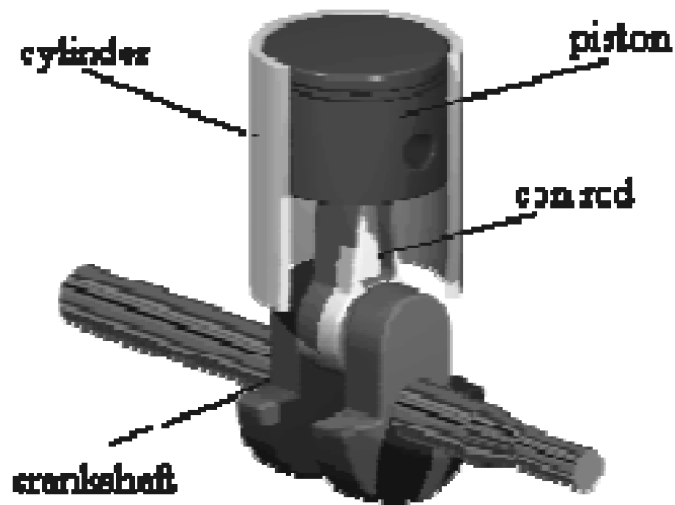


Closed chain



## Crank:

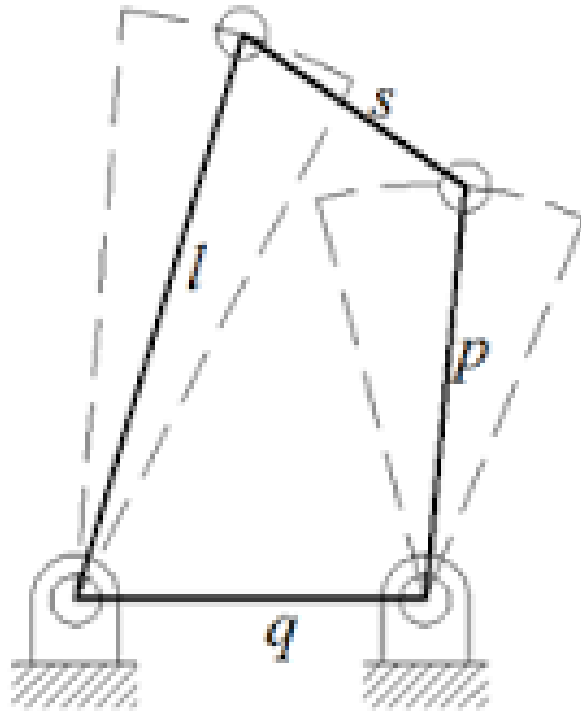
It is a simple link that is able to complete a full rotation about a fixed center.





## Rocker:

It is a link which has oscillatory (to & fro) rotation and is pivoted to ground.



Double rocker

## Coupler:

A mechanical device that serves to connect the ends of adjacent objects. It is type of link which has complex motion and not attached to ground.



## Ground:

It is a link which is fixed with respect to reference frame.

